

REMARKS

In view of the above amendments and the following remarks, reconsideration of the rejections contained in the Office Action of September 5, 2008 is respectfully requested.

By this Amendment, claims 1 and 5 have been amended. Thus, claims 1, 4, 5 and 8-10 are currently pending in the application. No new matter has been added by these amendments.

On pages 3-10 of the Office Action, the Examiner rejected claims 1, 4, 5 and 8-10 under 35 U.S.C. § 103(a) as being unpatentable over Borsboom et al. (US 4,981,661) in view of Tang et al. (US 6,019,954) and Forg et al. (US 5,660,807). For the reasons discussed below, it is respectfully submitted that the present claims are clearly patentable over the prior art of record.

Amended independent claim 1 recites a COS treatment apparatus for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The COS treatment apparatus of claim 1 includes a first reactor into which the gasified gas is to be introduced, with the gas having a temperature of at least 300°C, and a second reactor located at a downstream side of a gasified gas flow with respect to the first reactor. Claim 1 also recites that the first reactor comprises an O<sub>2</sub> removal catalyst for accelerating the following reaction: 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O, with the O<sub>2</sub> removal catalyst consisting of TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> or consisting of TiO<sub>2</sub> and NiO. Further, claim 1 recites that the second reactor comprises a COS conversion catalyst.

Amended independent claim 5 recites a COS treatment method for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The method of claim 5 includes removing O<sub>2</sub> from the gas by using an O<sub>2</sub> removal catalyst consisting of TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> or consisting of TiO<sub>2</sub> and NiO at a gas temperature of at least 300°C to accelerate the following reaction: 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O. The method of claim 5 also includes, after the removing of O<sub>2</sub> from the gas, converting COS contained in the gas to H<sub>2</sub>S by using a COS conversion catalyst.

Borsboom discloses a process for removing sulfur compounds from a CO containing gas. In particular, Borsboom discloses that O<sub>2</sub> is removed from a gasified gas by the hydrogenation of O<sub>2</sub> under a Co-Mo catalyst prior to the hydrolysis of COS. Borsboom also discloses that the hydrogenation of O<sub>2</sub> occurs in accordance with the following reaction: 0.5O<sub>2</sub> + H<sub>2</sub> → H<sub>2</sub>O + heat (Equation (6) of Borsboom).

However, as noted by the Examiner on page 3 of the Office Action, Borsboom does not

disclose an  $O_2$  removal catalyst consisting of  $TiO_2$  and  $Cr_2O_3$  or consisting of  $TiO_2$  and  $NiO$ , as required by independent claims 1 and 5. Further, it is noted that Borsboom does not disclose or suggest that a Co-Mo catalyst is an  $O_2$  catalyst which is capable of accelerating the reaction of:  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$ , as required by independent claims 1 and 5.

Tang discloses catalysts for the conversion of carbon monoxide with steam into carbon dioxide and hydrogen. In particular, Tang discloses a catalyst which includes a carrier having  $TiO_2$  and at least one catalytically active metal compound selected from the group consisting of oxides and sulfides of Co, Ni, Mo and W. On page 4 of the Office Action, the Examiner asserts that it would have been obvious to one of ordinary skill in the art to modify the  $O_2$  removal catalyst of Borsboom to be a  $TiO_2$  catalyst carrying  $NiO$  in order to improve the conversion of carbon monoxide with steam into carbon dioxide and hydrogen.

However, Tang does not disclose or suggest that selecting only one catalytically active metal compound from the group consisting of oxides and sulfides of Co, Ni, Mo and W improves the conventional Co-Mo system catalyst. Rather, Tang discloses an improved Co-Mo system catalyst, which requires Co or Ni and Mo or W (see column 1, lines 33-36; and column 3, lines 30-31), and does not disclose or suggest that the conventional Co-Mo system catalyst is improved by providing only one of Co, Ni, Mo and W. Accordingly, one of ordinary skill in the art would not have had a reasonable expectation of success based on Tang in selecting only one catalytically active metal compound from the group consisting of Co, Ni, Mo and W to provide a catalyst consisting of  $TiO_2$  and  $NiO$ , as required by claims 1 and 5.

Further, Tang only discloses a catalyst for the conversion of carbon monoxide with steam into carbon dioxide and hydrogen. Thus, Tang, like Borsboom, does not disclose a catalyst which is capable of accelerating the reaction of:  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$ , as required by independent claims 1 and 5.

Forg discloses a process for the removal of HCN from gas mixtures. In particular, Forg discloses a catalyst including  $TiO_2$  and  $Cr_2O_3$  for decomposing HCN and COS by hydrolysis, and for simultaneously suppressing the formation of COS from  $H_2S$  and  $CO_2$  in the gas mixture. However, Forg does not disclose that a catalyst including  $TiO_2$  and  $Cr_2O_3$  is an  $O_2$  removal catalyst for accelerating a reaction of  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$  at a temperature of at least

300°C, as required by independent claims 1 and 5. Accordingly, it would not have been obvious to one of ordinary skill in the art to use the catalyst including TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> of Forg as an O<sub>2</sub> removal catalyst for accelerating a reaction of 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O because Forg only discloses the catalyst including TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> as being a catalyst for decomposing HCN and COS.

Further, as indicated above, Forg discloses that a catalyst including TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> decomposes HCN and COS by hydrolysis, and simultaneously suppresses the formation of COS from H<sub>2</sub>S and CO<sub>2</sub> in the gas mixture. Therefore, Forg teaches away from using a catalyst including TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> as an O<sub>2</sub> removal catalyst for accelerating a reaction of 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O, because Forg disclose that a catalyst including TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> suppresses the formation of COS from H<sub>2</sub>S and CO<sub>2</sub> in the gas mixture.

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 1 and 5 is not disclosed or suggested by the Borsboom reference, the Tang reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Tang reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 1 and 5.

Independent claim 9 recites a COS treatment apparatus for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The treatment apparatus of claim 9 includes a reactor into which the gasified gas is to be introduced, with the reactor comprising *a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO*. Claim 9 also recites that *the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO is an O<sub>2</sub> removal catalyst for accelerating the following reaction: 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O, and that the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO is a COS conversion catalyst*.

Independent claim 10 recites a COS treatment method for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The method of claim 10 includes removing O<sub>2</sub> from the gas by *using a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO to accelerate the following reaction: 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O*. The method of claim 10 also includes *simultaneously converting COS to H<sub>2</sub>S by using the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO*.

It is noted that none of the Borsboom, Tang and Forg references discloses a catalyst comprising BaO. Therefore, none of the Boorsboom, Tang and Forg references discloses a reactor comprising a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO, as required by independent claim 9. Similarly, none of the Borsboom, Tang and Forg references discloses a method which includes removing  $O_2$  from the gas by using a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO, as required by independent claim 10. In this regard, it is noted that on pages 8 and 10 of the Office Action, the Examiner asserts that it would have been obvious to one of ordinary skill in the art to modify "the combined teachings of Borsboom et al and Tang et al such that the reactor comprising a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO..." so as to arrive at the invention of claims 9 and 10, but does not indicate how the applied prior art discloses or suggests a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO, as required by independent claims 9 and 10.

Further, as none of the Boorsboom, Tang and Forg references discloses a reactor comprising a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO, none of the Boorsboom, Tang and Forg references discloses or suggests that a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO is an  $O_2$  removal catalyst for accelerating the following reaction:  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$ , and wherein the catalyst is a COS conversion catalyst, as required by independent claim 9. For the same reason, none of the Borsboom, Tang and Forg references discloses or suggests a method which includes removing  $O_2$  from the gas by using a  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO to accelerate the following reaction:  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$ , and simultaneously converting COS to  $H_2S$  by using the  $TiO_2$  catalyst carrying  $Cr_2O_3$  and BaO, as required by independent claim 10.

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 9 and 10 is not disclosed or suggested by the Borsboom reference, the Tang reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Tang reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 9 and 10.

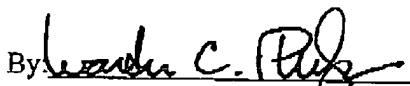
Therefore, it is respectfully submitted that independent claims 1, 5, 9 and 10, as well as claims 4 and 8 which depend therefrom, are clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice to that effect is respectfully solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, the Examiner is respectfully requested to contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

Masahiro HARADA et al.

By 

Walter C. Pledger  
Registration No. 55,540  
Attorney for Applicants

WCP/lkd  
Washington, D.C. 20006-1021  
Telephone (202) 721-8200  
Facsimile (202) 721-8250  
January 5, 2009